

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

# Opportunities within the Tech Base

Dr. Dave Thomas

Associate Director, Intelligent Ground Systems (IGS)

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## Furthering Unmanned Systems Autonomy

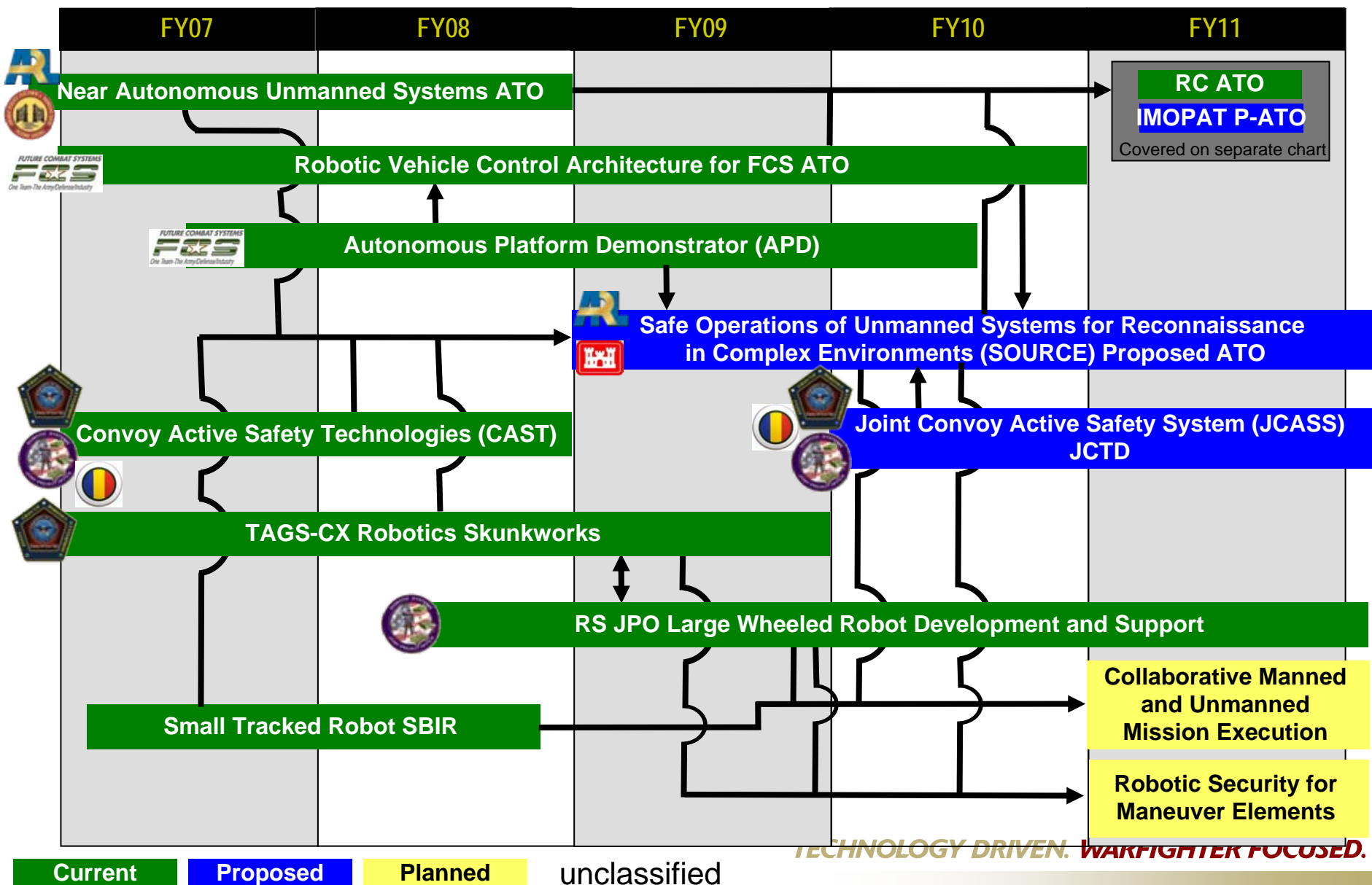
- Unmanned Ground Vehicle Platforms
- Vehicle Intelligence and Control
- Mission Payload Integration
- Embedded Simulation

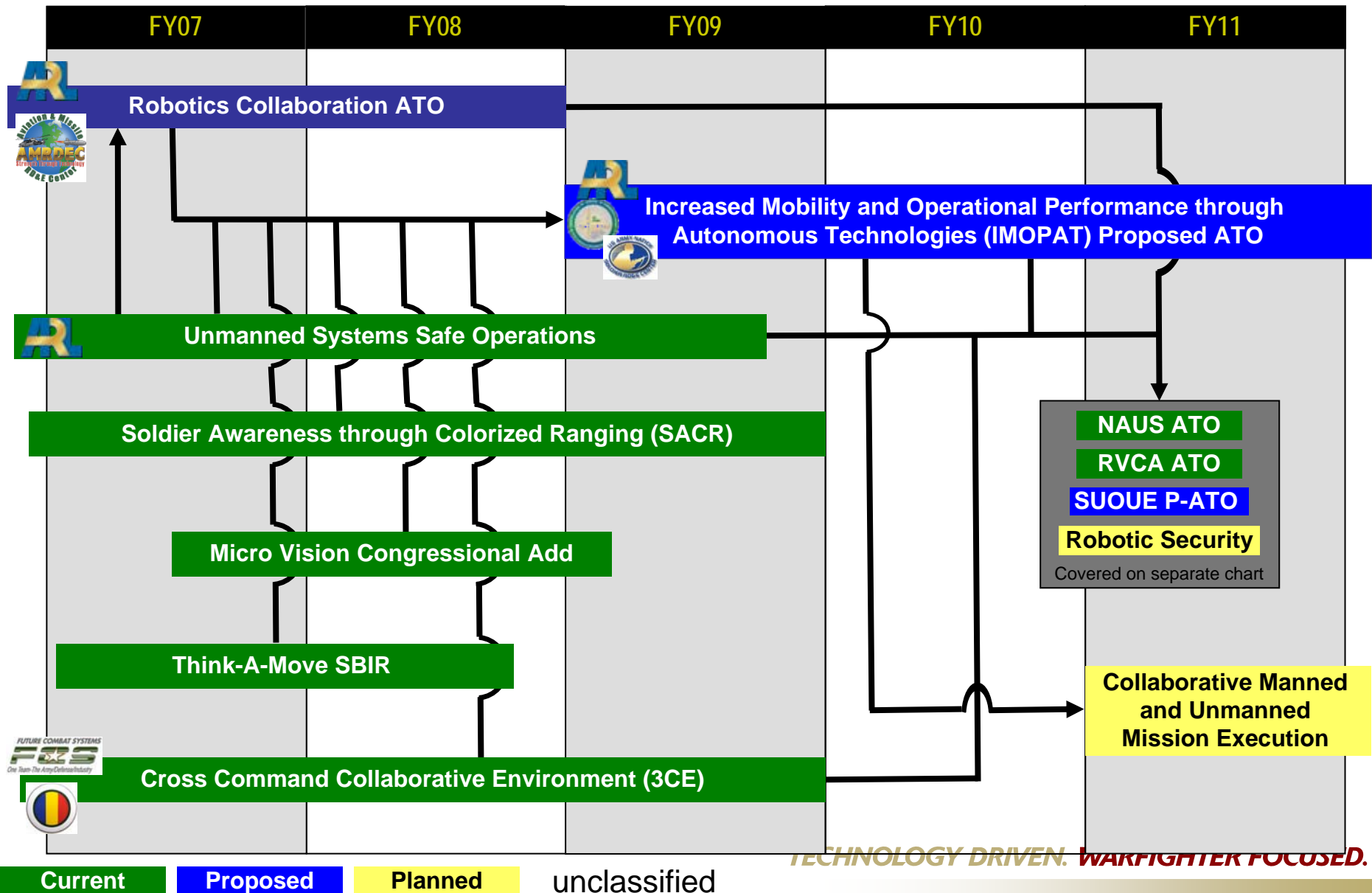


## Increasing Crew Interface and Control Capabilities

- Human-Robot Interaction
- Advanced Soldier Machine Interfaces
- Embedded Simulation









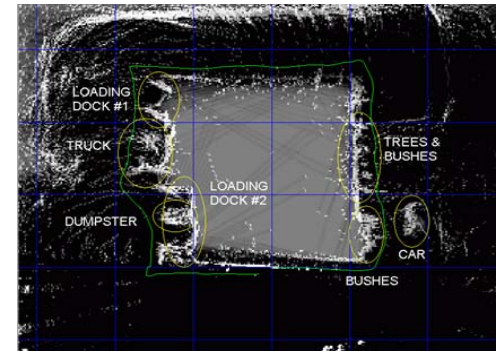
## Intrinsic Mobility



## Intelligent Mobility



Autonomous street following

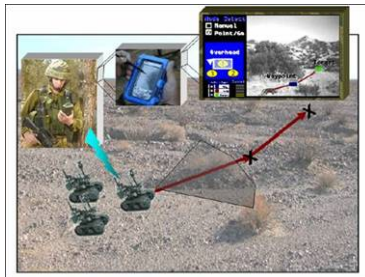
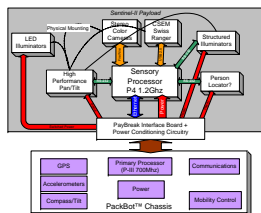


Autonomous perimeter following demonstration

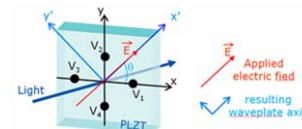
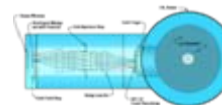
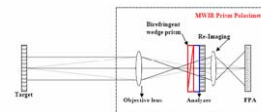
## Innovative Control



Sensor positioning for sub-vocal speech detection



## Advanced Sensors

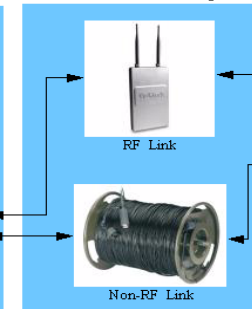


## Adaptive Payloads

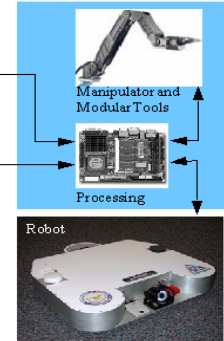
### Adaptive OCU and Controller

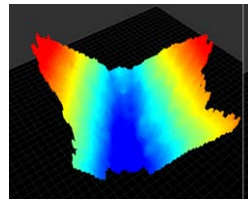
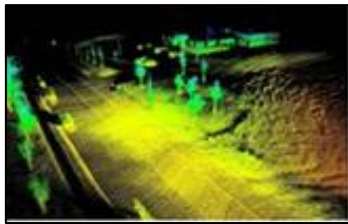
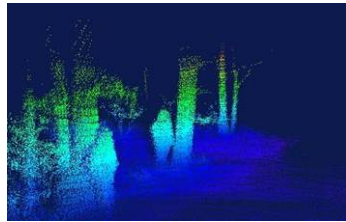


### Dual Communications Package

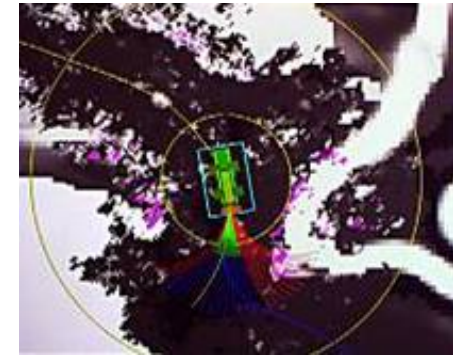
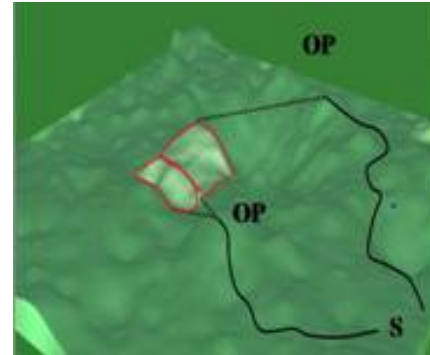


### Manipulator and Modular Tool Attachments



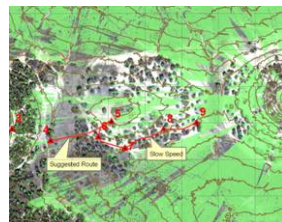


## Perception



## Intelligence

- Vehicle intelligence
- Tactical behaviors
- Collaboration
- Mission specific behaviors



## Command & Control

- Operator control interface
- Battle command integration



## Safety

- Vehicle safety
- Weapon safety



## Platform

- Mobility maturation
- SWaP

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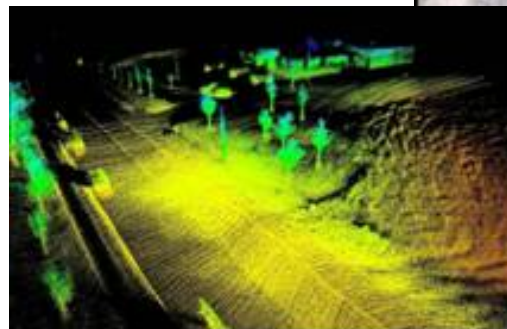
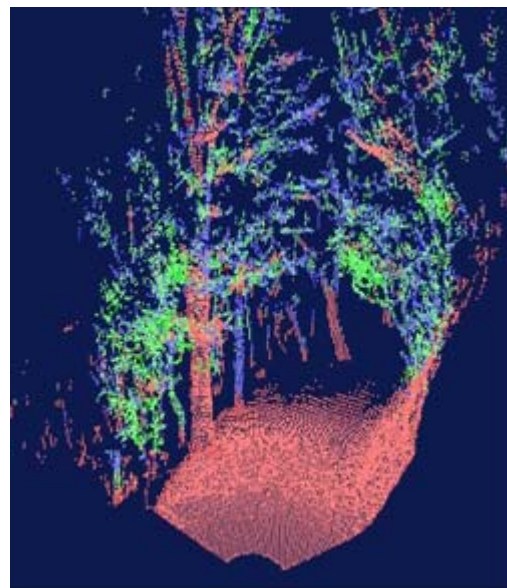


## Sensors

- Extended range & resolution
- All weather sensing/obscurants
- Reduced size

## Software

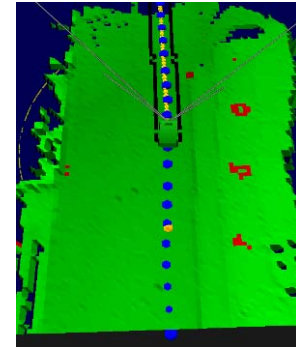
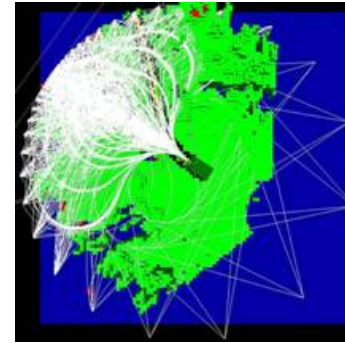
- Terrain/Feature classification at extended range
- Detection, classification, tracking of moving vehicles, people, & animals from a moving vehicle (object association/partial obscuration)
- Detection of moving & stationary people, often partially obscured or camouflaged
- Stand-off classification of mud or water – estimate of surface supportability/trafficability





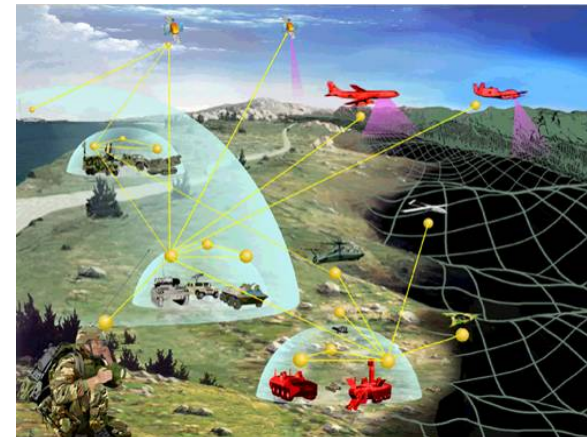
## Vehicle Intelligence

- Ability to adapt to changing environment & learn from prior experience or act based upon general guidance
- Ability to project future activity or courses of action by others and plan accordingly
- Ability to understand vehicle health and modify plans accordingly



## Tactical Behavior

- Mimic the behavior of Soldiers under similar conditions
- Continue autonomous operation during prolonged communications outages
- Self-protection

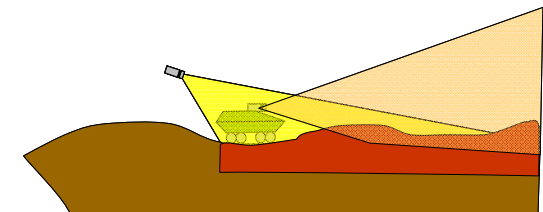


## Collaboration

- Shared situational awareness
- Teaming – robot/robot and robot/Soldier

## Mission Specific Behaviors

- RSTA
- Force Protection
- Material handling/delivery



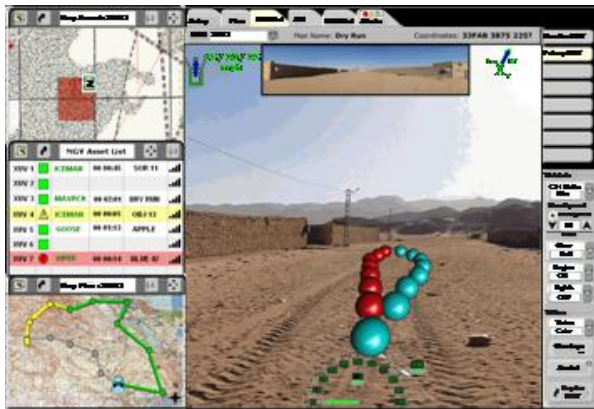
## Operator Control

- Situational awareness of what's going on around the robot/operator intervention
- Scalable interfaces – from MGTV to dismount
- Operator workload in realistic tactical environments
- Operator span of control
- Alternative control modes (voice/gesture)
- Hands free, heads up display and control



## Command Integration

- Fusion of local situation awareness information with the Common Operating Picture



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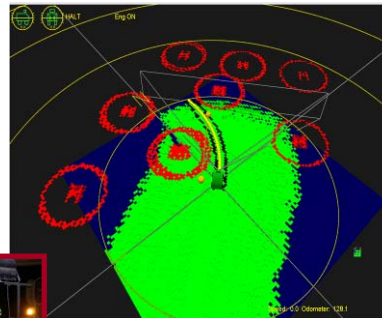
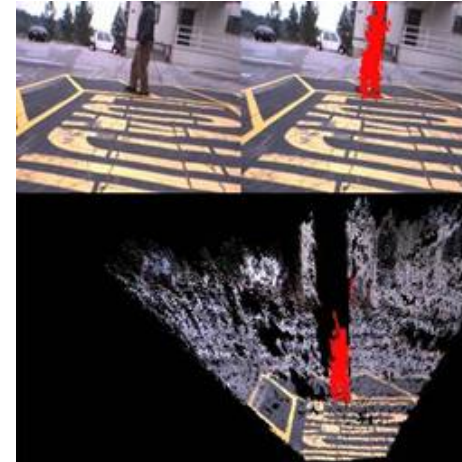
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## Safe Operations

- Autonomous Vehicle Mobility
- Autonomous Weapon Control

## Platform Technologies

- High bandwidth data links and network integration
- High density power sources
- System modularity/shape shifting designs
- Micro/miniaturization and Bio-mimetic designs
- Condition Based Maintenance

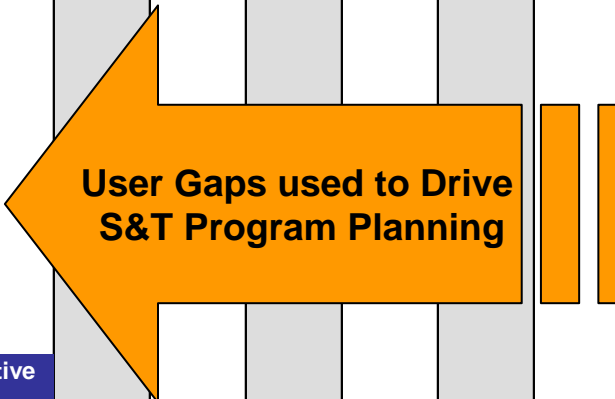
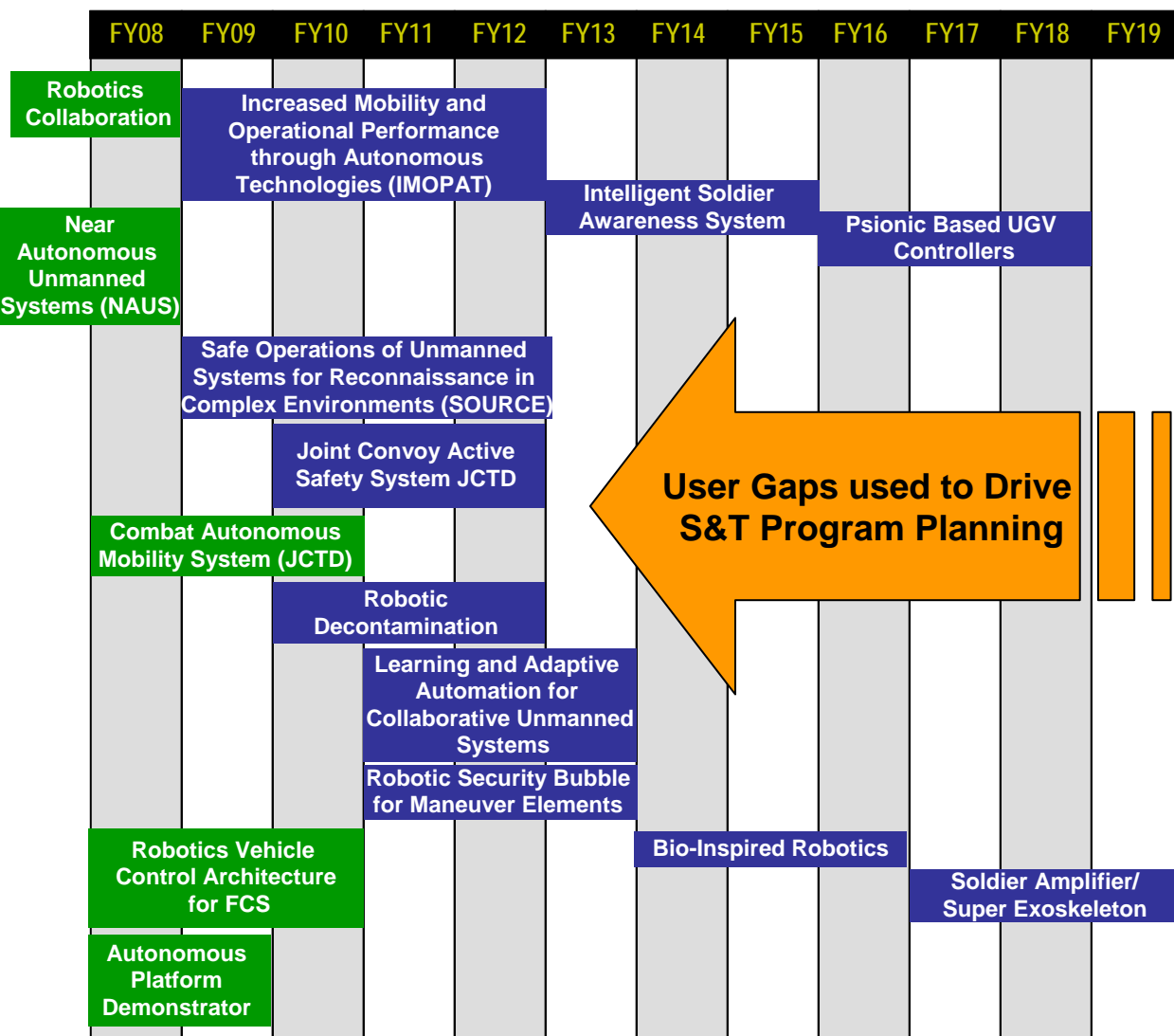


Advancing Fielded Capabilities

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- ### FCS Technology Gaps\*
- Higher levels of autonomy
  - Complex terrain agility
  - Higher speed capability
  - Enhanced situational awareness
  - Improved navigational accuracy
  - Enable passive sensors for autonomous navigation
  - Enhanced feature classification
  - Vehicle detection, classification and tracking
  - Human detection, classification and tracking
  - Learning and adaptation in both static and dynamic environments
  - Mobility in dynamic environment
  - Situational understanding in dynamic environment
  - Network constraints

- ### TRADOC Technology Gaps\*
- #### Current Force/Near Term Gaps
- Ability to remotely clear dangerous areas with robots
  - Convoy protection platform to defend and secure
  - Common robotics controller
  - Unmanned system teaming
  - Autonomous layered self-defense for UMS
  - UAV autonomously launch and land from moving manned vehicles
- #### Future Force/Mid Term Gaps
- Provide assured mobility.
  - Provide near-real time combat ID ... across the spectrum of operations.
- #### S&T/Far Term Gaps
- Mobile & Fixed 360 Degree Hemispherical Area Protection
  - Area/route clearance at operating speeds
  - Increase Autonomy in control of unmanned systems
  - Future Force Multi-modal HCI
  - Detect, identify, and neutralize CBRN/TIM agent dispersal modes

\* Not an all encompassing list!

Ongoing Program

Planned Program

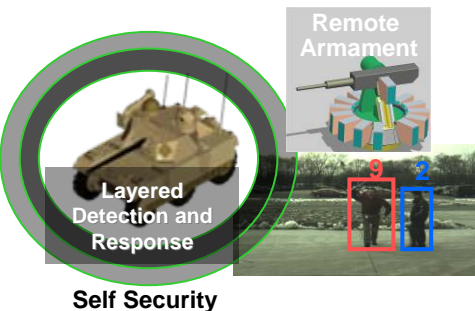
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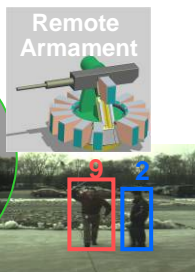
## Autonomous Mobility



Tactical Behaviors



Self Security



## Schedule

Milestones	FY06	FY07	FY08	FY09
Longer range, higher resolution perception (ARL)			5	
Personnel & vehicle detection & avoidance (ARL)			5	
Tactical Behaviors (ARL/TARDEC)			5	
System self security (TARDEC)			5	
Remote weapon station (ARDEC)			5	5
Integrated reduced workload human interface (ARL)			5	
Autonomous unmanned vehicle field exercises (ARL)	▲	▲	▲	
Capstone Experiments (TARDEC)			5	

## Purpose:

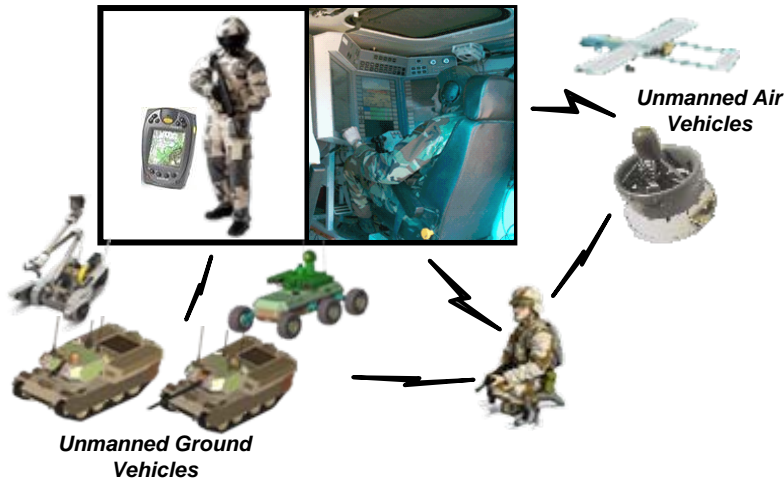
*Develop and demonstrate key robotics technologies to reduce risk for PM FCS (BCT) and increase the utility of future unmanned systems.*

## Product:

- *Near-autonomous maneuver in environments relevant to FCS*
- *Validated tactical behavior methodology and integrated tactical behaviors*
- *System self security – fundamental technology for detection & tracking, and responding to incoming threats.*

## Payoff:

- *Unmanned systems able to meet FCS threshold operational requirements*
- *Reduced burden on soldier & network*
- *Unmanned systems with greater survivability*



Focus on **Platoon and below** operations

## Purpose:

*Develop the tools, techniques, & autonomy to maximize mounted and dismounted control of ground and air unmanned systems and optimize Soldier-robot and robot-robot ground and air teams*

## Results:

- Increased OPTEMPO through coordinated Soldier-robot interactions during degraded autonomous modes
- Increased robot planning capability and understanding of UV intent and operational environment
- Unmanned Vehicles safety operational behavioral algorithms and recommendations for TTP development
- Software for UAV/UGV collaboration
- UAV autonomy and cooperative engagement capability

## Schedule

MILESTONES	FY04	FY05	FY06	FY07	FY08	FY09
Common scalable interface dev't (ground & air)			5		6	
Intelligent agents and adaptive automation			5		6	
UV autonomy & task distribution algorithms	3	4	5	6		
UV collaborative behaviors	3	4	5	6		
Flight Demos			5	6		
Model Validation and Experimentation (FCS MGV UGV & UAV)			5	5	6	

## Payoff:

- Increased mission performance through reduction of task timelines, robot interactions, and cognitive burden with increased adaptive automation & collaboration
- Reduced Soldier training burden through standardized interfaces
- Improved safety of operations around unmanned vehicles
- Optimized span of control for unmanned systems
- Increased Soldier/system engagement effectiveness

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360/90 Day/Night  
Near-field Sensor Coverage



Soldier Monitoring  
& State

Advanced  
Crew Stations



Integration Platform  
With IV System



**Integrate, Enhance, Demonstrate  
360 LSA/Assist-Mob/Soldier Monitor & State  
to Maximize Soldier-System  
360 LSA and Mobility Capabilities  
(Secure Mobility)**

## Schedule

MILESTONES	FY09	FY10	FY11	FY12
<b>M&amp;S and Field Experiments</b>				
<b>Local 360 SA</b>				
- Task Analysis				
- Integrate Detection Algorithms				
- Integrate Digital Recording				
- Integrate Dismount System				
<b>Improved Mobility</b>				
- Soldier Task Balancing				
- Assisted Mobility				
<b>Soldier Monitor/State CS System</b>				
- Sensor Integration				
- Algorithm Integration				
- Integration Technique				

## Purpose

Enable indirect vision (IV) based Soldier-systems (manned/unmanned/Soldier) to move quickly and safely while maintaining 360 local situational awareness (LSA) to enhance operational performance.

## Product

- Advanced Crew Stations integrated with 360/90 Day/Night LSA, Assisted Mobility, and Soldier Monitoring / State technologies to improve Soldier performance.
- Quantitative understanding (performance levels) of future indirect vision operations for the movement and security of Soldier-systems at a platoon and below level when utilizing:
  - Assisted mobility
  - LSA system with aided target cueing
  - Digital video recording of 360/90 with intelligent tagging
  - Soldier monitoring and state based crew station (CS) design

## Payoff

- Improvement in Vehicle & Soldier Survivability, Vehicle Lethality/Self-Defense & Control along with Greater Survivability/Lethality for Dismount Soldiers
- Two Mounted Soldier ability to maintain 360 LSA with IV
- One Mounted Soldier ability to move vehicle (manned or unmanned) quickly and safely with IV
- Data and Information to feed programmatic decisions
- Risk reduction for FCS

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## TARDEC

- Develop Enhanced Indirect Vision Drive / Tele-operation Systems
- Develop Assisted Autonomy Systems
- Develop Warfighter Machine Interfaces
- Integrate and Evaluate
  - Vehicle LSA Systems (NVESD)
  - Soldier Monitoring & State Classification Systems (NSRDEC/ARL-HRED)
  - Assisted Mobility (Other TARDEC Programs)
  - Dismount LSA Systems (NSRDEC)
- Perform SIL and Vehicle/Field Experiments



## ARL-HRED

- Define and Develop Experimentation Plans
- Work with TARDEC on Indirect Vision Drive and Assisted Autonomy Systems
- Provide HFE Support for Systems Development and Integration
- Develop Information Flow Requirements and Algorithms for Mobility and LSA
- Work with NSRDEC on Soldier Monitoring and Workload Management Systems



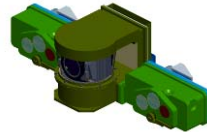
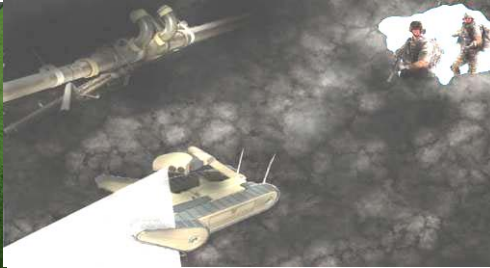
## CERDEC NVESD

- Enhance DAS Sensor Systems / Threat Detection Algorithms
  - Pop-Up Targeting and Gun-Fire Detection (before/during/after shot)
- Develop Digital Vehicle LSA Recording and Cueing System



## NSRDEC

- Enhance and Transition Mid-Maturity Dismount Soldier Monitoring Systems from Augmented Cognition Program
- Develop/Enhance Low-Maturity Soldier Monitoring System
- Work with ARL-HRED on Soldier Monitoring Systems
- Develop Dismount LSA System



## Purpose:

*Develop and demonstrate key robotic technologies that will be required for autonomous collaborative unmanned systems & Soldiers to conduct urban operations, permitting effective utilization of UMS for the full spectrum of warfare.*

## Products:

- *Integrated testbeds and Soldier experimentation providing quantitative performance data to enable development of TTPs & entry into future SDD programs*
- *Demonstration of Improved UMS performance software and algorithms for:*
  - *Operations in dynamic/urban environments*
  - *Collaborative persistent surveillance*
  - *Intuitive supervision of UMS by Soldiers*
  - *Tactical behavior for multi-mission applications*
  - *Small robot autonomy behaviors*

## Payoff:

- *Safer operations of UGVs in proximity to pedestrians and vehicles*
- *Increase in vehicle autonomy to enable less supervisory burden*
- *Increased UGV situational awareness*
- *Robust Soldier/robot and robot/robot teaming behaviors*
- *Robust UGV performance in all environments/conditions*

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## Schedule

MILESTONE (FY)	09	10	11	12
Technology/Requirements Assessment	█		█	
Perception & Control Technologies	█	5	█	6
- Safe Operations, Situational Awareness				
Tactical/Mission Behavior Technologies	█	5	█	6
- Cooperative & Dynamic Behaviors				
Platform Integration		█		█
Engineering Evaluation		▲	▲	▲
M&S Experiments		█	█	█
Field Experiments		5		6



## TARDEC



- Integration of technology & payloads into testbed platform
- Development & conduct of warfighter assessment & engineering evaluations (capstone events)
- Conduit to Battlelabs for TTP developments & integration of appropriate technology into testbeds
- Technology maturation prior to integration (e.g., enhanced robustness, functionality, reliability)
- Technology transition to acquisition partners

## ARL/VTD



- Develop perception sensors & algorithms for navigation and mission execution in dynamic urban environments
- Develop planning algorithms for use by heterogeneous UMS in dynamic environments with adversaries and non-combatants, includes collaboration by UMS & Soldiers
- Develop tactical behavior for focused upon manned-unmanned teaming in urban operations
- Develop a hard-ware-in-the-loop simulation to encompass vision based/LADAR sensing

## ARL/HRED

- Conduct simulations to evaluate soldier-robot teaming; trust in automation; tolerance to system failure;
- Evaluate intuitive interface concepts for supervisory control - optimization of task allocation

## ARL/CISD

- Develop autonomous behavior for a SUGV class vehicle, including assisted teleoperation

## ERDC



- Develop a physics-based, multiscaled, terrain-enriched virtual testing capability.
- Evaluate algorithms for sensor fusion
- Develop and evaluate algorithms for UGV autonomous tactical behaviors